

A Study on the Change of Business Functions and Business Trips in Tokyo Metropolitan Region : A Case Study of Shinjuku Sub-Center

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**A STUDY ON THE CHANGE OF BUSINESS FUNCTIONS AND
BUSINESS TRIPS IN TOKYO METROPOLITAN REGION
- A Case Study of Shinjuku Sub-Center -**

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1. INTRODUCTION

Tokyo Metropolitan Region, which has about thirty million people within a 50km radius, is facing serious urban problems such as traffic congestion, long distance commuting, and a housing shortage due to unaffordable prices.

Shinjuku Sub-Center, located 5km west of the existing center of Tokyo, has been developed since the 1970s in order to solve these problems. Nowadays, Shinjuku Sub-Center has grown into one of the biggest centers in the Tokyo Metropolitan Region.

The aim of this paper is to investigate the process of concentration of business functions in Shinjuku and analyze the change of business trips between Shinjuku and the existing center as well as commuting trips to these centers, using the data of Person Trip Surveys which were conducted in 1968, 1978 and 1988.

2. PRESENT CONCENTRATION OF FUNCTIONS INTO TOKYO AND URBAN POLICY

2.1 Concentration of Functions into Tokyo Metropolitan Region

The total population of Japan was about 123 million in 1990 and about 32 million people, or 25.7%, was residing within a 50km radius of Japan's capital of Tokyo, whose total land area covers only 3.6% of Japan, (hereinafter referred to as "Tokyo Metropolitan Region", an aggregate of the four administrative bodies of Tokyo Metropolis, Kanagawa Prefecture, Saitama Prefecture, and Chiba Prefecture, which make up the commuting hinterlands of Tokyo). Tokyo Metropolitan Region took up some 40.6% of the increased population of Japan during the 20 years between 1970 and 1990. This increasing trend is expected to continue even in the future.

Table-1 Concentration of functions into the Tokyo Metropolitan Region (T.M.R)

Item	year	T.M.R share in Japan	23Wards share in T.M.R	3Wards share in T.M.R
1) Land Area	1990	3.6%	4.5%	0.3%
2) Residential Population	1990	25.7%	25.7%	0.8%
3) Increase of residential population	70-90	40.6%	-8.8%	-1.8%
4) Working population based on the place of work	1990	26.7%	44.1%	14.5%
5) Annual products of manufactures	1992	23.6%	17.1%	3.1%
6) Annual sales of wholesale trade	1991	41.2%	82.4%	64.8%
7) Number of corporations capitalized over one billion yen	1991	55.6%	85.0%	58.7%
8) Number of information service workers	1991	55.2%	71.8%	37.7%
9) Outstanding amounts of deposits of all banks	1993	41.1%	79.5%	57.8%
10) Number of theaters and halls	1994	25.0%	47.3%	12.8%
11) Frequency of concerts and performances	1988	60.2%	90.1%	*****

Source: 1-9) National Land Agency (1994) Development of the Metropolitan Region

10) Ministry of Health and Welfare (1994) The Report on the Health and Welfare Administration Services

11) National Land Agency (1994) The Report on the New Life and Culture Functions in the Capital Region

Note: [*****] : not available

In terms of the concentration of urban functions, not only the head offices of firms having a capital over one billion yen, but also information service functions, financial functions and cultural functions are concentrated in the Tokyo Metropolitan Region.

On the other hand, although the ratio of concentration of such urban functions as the working population, head offices of firms, and information and specialized service workers is high in the 23 wards of Tokyo, the hub of the Region, the number of residents has been decreasing.

2.2 Urban Policy and Problems in Tokyo Metropolitan Region

As most of the urban problems generated in the Tokyo Metropolitan Region (high land prices, difficulty in acquiring housing, traffic congestion, long commuting hours, etc.) may be attributable to the excessive concentration of business and other functions in the center of Tokyo, it is regarded as necessary to remodel the Region into a "structure with diversified core cities", and to give the 23 ward areas a "multi-core urban structure". [1,2]

It is now planned, therefore, to improve the functions of such core business cities and their hinterlands 20-30km away from Tokyo as Yokohama-Kawasaki, Urawa-Omiya, Chiba-Makuhari, Tachikawa-Hachioji, and Tsuchiura-Tsukuba-Ushiku, with a view to moving and diversifying business functions concentrated in the existing center or the 23 wards of Tokyo. The improvements have been completed in parts of Yokohama and Makuhari, but the business functions which were moved or newly-established are mostly those related to research & development and information processing. [3] Very few companies including the head office came from the center of Tokyo. Furthermore, some common problems in terms of business and the everyday life of these cities have been pointed out: there are insufficient railroads, roads and other public facilities, and also poor access to commercial and cultural functions. [4]

In building up core business cities, which are essential to establishing a structure with diversified core cities, it is necessary to clarify what business functions are to be established there and for what kinds of business.

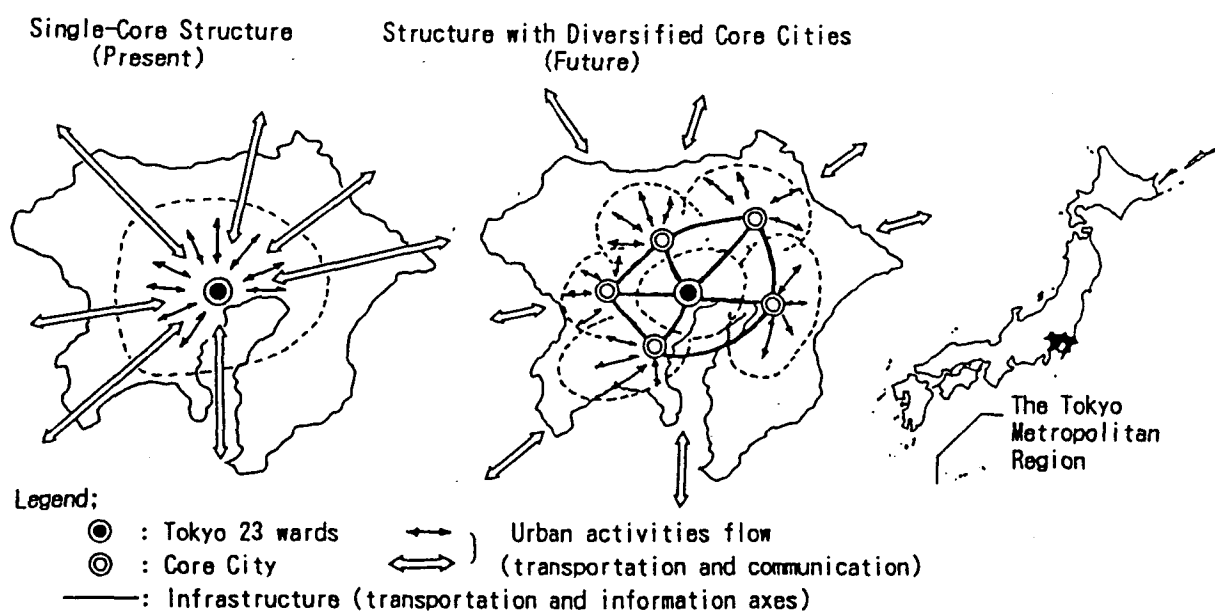


Figure-1 Development plan of the Tokyo Metropolitan Region

3. THE PURPOSE OF THE STUDY AND ITS PROCESS

3.1 The Purpose of the Study

Generally speaking, the establishment of business functions is determined by such pull factors as easy access to clients, financial institutions, and ministries/agencies for license/approval; multiple information channels; and convenient public transportation, and such push factors as the high cost of establishing an office, long commuting hours, and high housing costs. [5,6]

About these factors there is a study on the effect of urban improvement on promoting the concentration of urban functions and also on the importance of improving transportation facilities. [7]

There is also another study which quantitatively clarifies factors affecting the concentrated amount of business trips and the time of stay in business areas.

There is however no study analyzing regional and functional connections among business areas from the point of business trips. [8]

Taking this background into consideration, this study aims at positively clarifying the process of formation of business areas and their regional and functional connections, and also the influence of the formation on commuting and business trips. Therefore, this study positively analyzes Shinjuku Sub-Center, which has been improved as Tokyo's business sub-center, based on the results of the Person Trip Survey which has been conducted three times in the past 20 years.

3.2 Areas Covered by the Study

(1) Areas Covered by the Study

This study covers the wards of Chiyoda, Chuo and Minato, which are the administrative and economic center and in which almost all central control functions are concentrated (hereinafter referred to as "the three central wards". They are located in the center of Tokyo's 23 wards. Although they occupy only 6.9% of the total land area, they have about 33% of the working population of the 23 wards.), and Shinjuku ward including Shinjuku Sub-Center has about 8% of the working population of the 23 wards.

The construction of Shinjuku Sub-Center, 5km west of the center of the three wards, began in the middle of the 1960s. In 1991 Tokyo City Hall moved, completing Tokyo's new business center with 12 skyscrapers and about 190ha of floor space.

The construction of office buildings encouraged the moving of firms and 29 companies listed on the Tokyo Stock Exchange's first section moved their head offices to Shinjuku Sub-Center by 1991. The number is very small when compared with the 477 companies whose head offices are in the three central wards. However, taking account of the fact that the Makuhashi New Sub-Center, which is now under construction at a site 30km east of Tokyo, has only nine head offices, it can be said that Shinjuku Sub-Center has the highest concentration rate of core business functions following the center of Tokyo.

The business trip data used in this study were obtained from the Person Trip Survey in Tokyo Metropolitan Region (hereinafter referred to as "PT"). The 68PT (PT in 1968) corresponds to the period before the construction of the Sub-Center, the 78PT to the middle of construction when about 45% of the floor space was completed, and the 88PT to the period when most of the build-up was completed except for the New Tokyo City Hall. It

can be judged, therefore, that the results of the past three PTs are important and valuable data objectively describing the formation process of Shinjuku Sub-Center and the changes in business activities there over the past 20 years.

As the minimum district unit, this study uses the "basic planning zones" of the PT, taking account of the distinct characteristics as an area of business concentration and the ease of obtaining data.

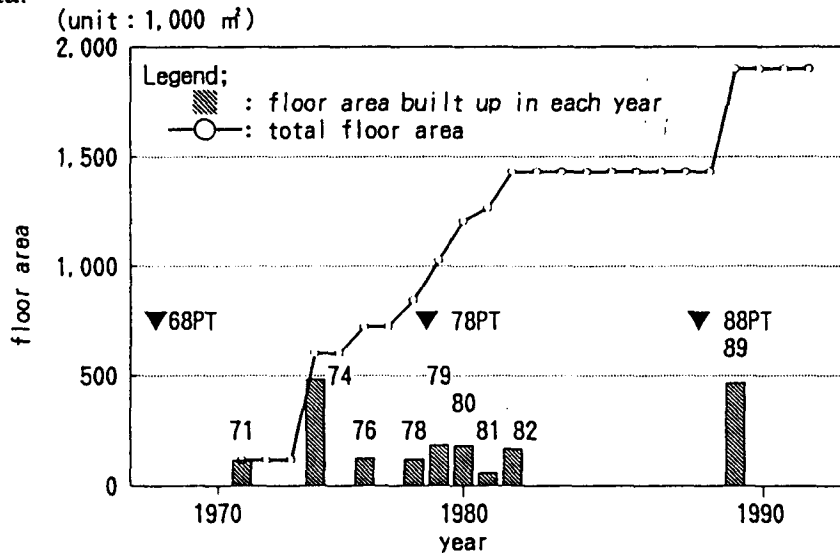


Figure-2 Formation of Shinjuku Sub-Center

(2) Grouping of Districts

Districts to be studied are grouped into the following three districts:

a) The heart of Tokyo: a district where economic, administrative and cultural functions are concentrated, including Marunouchi, Otemachi and Kasumigaseki.

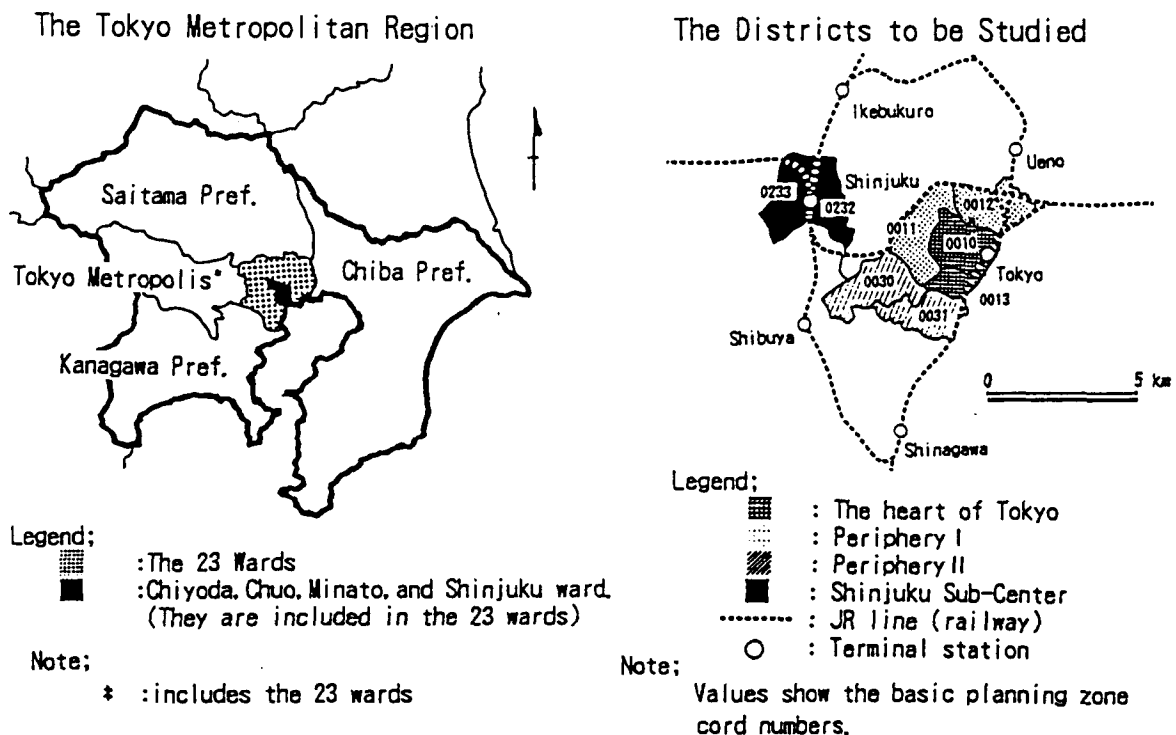


Figure-3 Map of the districts to be studied

Table-2 The districts to be studied

The Districts to be studied	The basic zone of PT/The name of place	Area (km ²)
The heart of Tokyo	0010 Marunouchi, Otemachi, etc	3.74
	0013 Kasumigaseki, Uchisaiwaicho. etc	1.01
Periphery I	0011 Nagatacho, Kudan, Iidabashi, etc	3.74
	0012 Kanda, Iwamotocho, etc	3.03
Periphery II	0030 Akasaka, Aoyama	4.21
	0031 Toranomon, Shinbashi, Shibakouen.etc	4.31
Shinjuku Sub-Center	0232 Shinjuku, Kabukicho, etc	3.45
	0233 Nishi-Shinjuku (Sub-Center), Kita-Shinjuku	3.40

b) Periphery of the heart of Tokyo: districts between the heart of Tokyo and Shinjuku Sub-Center, which may have close business ties with the two districts. The term "Periphery I" is defined as the northwestern part to the heart of Tokyo, including the Chuo and Tozai railway lines connecting the two districts. The term "Periphery II" is defined as the southwestern part including the Marunouchi subway line.

c) Shinjuku Sub-Center: a district including the city sub-center to the west side of Shinjuku Station and the area along Shinjuku-dori roads to the east, in which business is concentrated.

3.3 Contents of the Study and Data Used

(1) Contents of the Study

The objectives of this study are the following:

- To clarify the time series changes and characteristics of the concentration of business functions into Shinjuku Sub-Center
- To analyze the relationship between the concentration of business functions into the target districts and the business trips springing from the concentration
- To analyze connections of business trips between districts or functions.
- To establish share models of transportation means of business trips.
- To grasp the effects of the formation of Shinjuku Sub-Center quantitatively.

(2) Data used

The original data of the Person Trip Surveys, which were conducted in 1968, 1978 and 1988 in Tokyo, were used to re-collect business-related trips for analysis. A "business trip" mentioned here means a trip originating from a place of work or a place of business and intended to visit another place of business.

It has been confirmed that the sampling accuracy of the business trip data is secured 20% which is the standard accuracy (relative error) of the PT.

In order to observe the industrial structure of each target district, the numbers of workers in accordance with the major groups of the industrial classification of the establishment census of Japan in towns and villages are re-compiled for the basic planning zones. To elucidate occupational structure, the "working population" following the major groups of the occupational classification used in the population census of Japan was used.

4. CONCENTRATION OF BUSINESS FUNCTIONS AND THEIR CHARACTERISTICS IN THE DISTRICTS TO BE STUDIED

4.1 Progress of workers and its characteristics

According to the establishment censuses, the number of workers in the heart of Tokyo showed an increasing trend from 1969 to 1978 and a decreasing trend from 1978 to 1986. On the other hand, the number of workers in Peripheries I and II was observed to increase about 1.8 times in the 17 years, although the rate of change slowed down from 1978 to 1988. In contrast to this, that number increased by 2.27 times in the 17 years in Shinjuku Sub-Center, showing a greater growth than other districts. Thus, the concentration of the business functions of the heart of Tokyo came to a matured level, as considered in terms of the number of workers, but the Peripheries and Shinjuku Sub-Center kept up an increasing trend. Shinjuku Sub-Center, in particular, grew remarkably in its concentration of business functions. (Table-3)

Table-3 Changes in the number of workers

		The heart of Tokyo	Periphery I	Periphery II	Shinjuku Sub-Center
The number of workers (1000-persons)	1969	307	272	277	139
	1978	379	432	402	233
	1986	370	490	491	314
Rate of increase	78/69	1.23	1.59	1.45	1.68
	86/78	0.98	1.13	1.22	1.35
	86/69	1.21	1.80	1.77	2.27
Rate of change (annual average rate)	69-78	2.36%	5.29%	4.22%	5.93%
	78-86	-0.30%	1.58%	2.53%	3.82%

Source: The General Affairs Bureau's "1969, 1978 and 1986 Establishment Census of Japan"

4.2 Classification of Workers' Occupation and Industry

According to the population censuses, the ratio of the office workers (professional and technical workers, managers and officials, and clerical and related workers) in the heart of Tokyo was kept at about 65%. But the figure of the Shinjuku Sub-Center increased from 38% to 51% in the 20 year-period from 1965 to 1985, indicating that in parallel with the increase in the number of all workers, office workers increased.

Of the changes in the industry-wise number of workers during the 8-year period from 1978 to 1986, those in the financing/insurance and service industries are distinctive. Despite a decrease in the total working population in the heart of Tokyo, the number of workers in these industries was increasing. (Table-4)

In the peripheries of the heart of Tokyo and Shinjuku Sub-Center, the total number of workers increased, and especially conspicuous were workers engaged in services, wholesale and retail trade, and financing/insurance. (Table-4)

Table-4 Changes in the number of workers in the financing/insurance

(unit: persons)

Major groups of classification		The heart of Tokyo	Periphery I	Periphery II	Shinjuku Sub-Center
Financing/insurance	1978	50,058	20,607	16,595	21,704
	1986	57,867	24,420	19,880	26,927
	86/78	1.16	1.19	1.20	1.24
Services	78/69	40,056	101,998	106,142	53,946
	86/78	54,494	147,622	155,993	95,137
	86/69	1.36	1.45	1.47	1.76

Source: The General Affairs Bureau's "1969,1978 and 1986 Establishment Census of Japan"

Table-5 The industrial structure in the financing/insurance in 1986

(unit : persons)

Districts	Total (financing/insurance)	Bank/Trust	Stockbroking /Commodity exchange	Insurance	Others
The heart of Tokyo	57,867 (100%)	34,035 (58.8%)	4,734 (8.2%)	12,222 (21.1%)	6,876 (11.9%)
Periphery I	27,420 (100%)	7,131 (26.0%)	877 (3.2%)	10,665 (38.9%)	8,747 (31.9%)
Periphery I	19,880 (100%)	6,584 (33.1%)	2,937 (14.8%)	3,227 (16.2%)	7,132 (35.9)
Shinjuku Sub-Center	26,927 (100%)	3,521 (13.1%)	3,407 (12.6%)	13,379 (49.7%)	6,620 (24.6)

Source: The General Affairs Bureau's "1986 Establishment Census of Japan"

Table-6 The industrial structure in the service industries in 1986

(unit : persons)

Districts	Total (service)	Information/research	Specialized service	Other professional service	Others
The heart of Tokyo	54,494 (100%)	8,543 (15.7%)	9,151 (16.8%)	12,197 (22.4%)	24,603 (45.1%)
Periphery I	147,622 (100%)	32,432 (22.0%)	23,121 (15.7)	24,413 (16.5%)	67,656 (45.8%)
Periphery I	155,993 (100%)	27,646 (17.7%)	31,760 (20.4%)	23,749 (15.2)	72,830 (46.7%)
Shinjuku Sub-Center	95,137 (100%)	17,715 (18.6%)	13,491 (14.2)	19,291 (20.2%)	44,700 (47.6%)

Source: The General Affairs Bureau's "1986 Establishment Census of Japan"

The ratio of the number of workers in the financing/insurance industry to the whole working population in the heart of Tokyo was 15.6%, but the figure was about 5% in the peripheries and 8.6% in Shinjuku Sub-Center, indicating that the concentration of the financing/insurance industry in the heart of Tokyo was extremely higher than other districts. In the

heart of Tokyo, banks and trust banks accounted for 58.8% of the total number of financing/insurance workers, and in Shinjuku Sub-Center, insurance companies occupied 49.7%, clearly showing that the heart of Tokyo and Shinjuku Sub-Center have differences in the structure in the financing/insurance industry. (Table-5)

On the other hand, in the heart of Tokyo, the service industry workers occupied 14.7% of all the workers there, and in the peripheries and Shinjuku Sub-Center, the figure was about 30%. The service industry had much weight in the peripheries and Shinjuku Sub-Center. In a breakdown of the service industry, in every area, information/research, specialized and other professional services industries occupied 53-55%. (Table-6)

5. FORMATION OF SHINJUKU SUB-CENTER AND CHANGES IN BUSINESS TRIPS

5.1 Changes and Characteristics of Business Trips

(1) Changes in the Number of Business Trips

The change in the generation/attraction of business trips in the past 20 years shows that these trips have been consistently decreasing in the heart of Tokyo, that they have been stagnant in Periphery I, and that they have been increasing in Periphery II and Shinjuku Sub-Center. In order to scrutinize the discrepancy among the districts, the next section analyzes the generation/attraction of business trips in accordance with industrial and occupational characteristics.

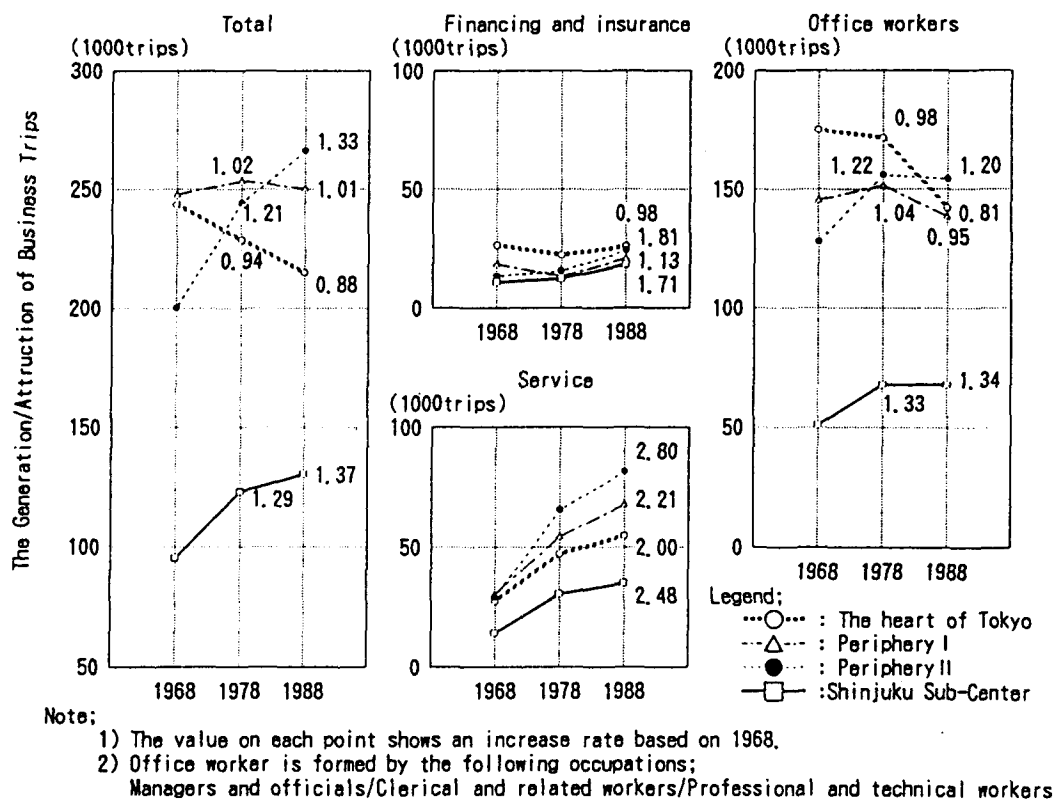


Figure-4 Changes in the number of business trips

(2) Changes in Business Trips in accordance with Industries and Occupations

a). Industry-wise Business Trips

This section deals with the financing/insurance industry and the service industry where the number of workers has changed remarkably; to analyze the changes and characteristics of the generation/attraction of business trips in these industries.

In 1988, the ratio of the trips in the service industry to all business trips was 25% to 30% in each district. The number of trips in the service industry increased more than twofold in 20 years. Those in Shinjuku Sub-Center increased by about 2.5 times, which is a little higher than other districts.

On the other hand, the ratio of the trips in the financing/insurance industry to the whole business trips was 12% in the heart of Tokyo, Periphery I 8.4%, Periphery II 9.4%, and Shinjuku Sub-Center as high as 14%. Although the increase rate in the part 10 years in the heart of Tokyo decreased to 0.98, Shinjuku Sub-Center increased by 1.7 times.

This means that in the heart of Tokyo and Shinjuku Sub-Center, the difference in the structure of the service industry and the financing/insurance industry had a great influence on the generation/attraction of business trips.

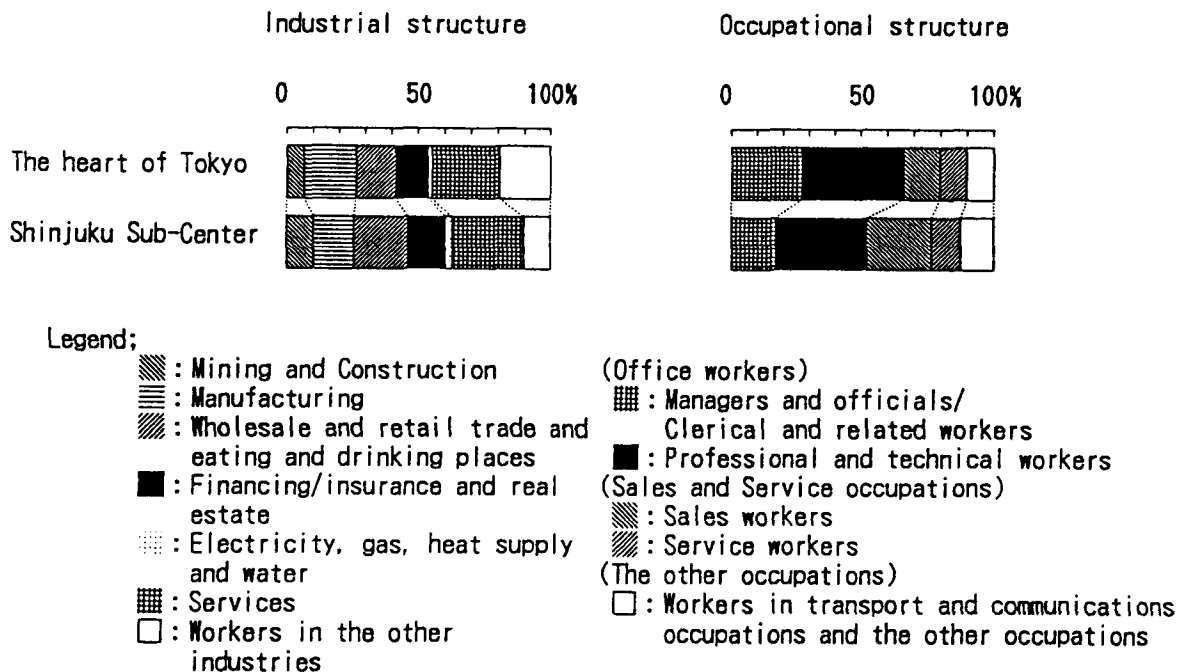


Figure-5 Composition of business trips by industries and occupations

b) Occupation-wise Business Trips

This section deals with the office workers and the sales/service workers whose numbers has changed remarkably, and analyzes the changes and characteristics of the generation/attraction of their business trips.

Although business trips of the office workers in the heart of Tokyo account for 65% of all the business trips, they were reduced to 0.81 during the past 20 years. Concentration of business functions was very high, but business trips almost hit the ceiling. In Shinjuku Sub-Center, however, the office workers were responsible for 50% of all the business trips, and as the rate of increase was 1.34, business trips of the office workers are expected to keep going up.

Business trips of the sales/service workers in the heart of Tokyo increased only 1.09 times, accounting for 24% of all the business trips in 1988. On the other hand, during the same period, the figures in Shinjuku Sub-Center were 1.39 and 36%, characteristically showing that the sales/service workers in the Sub-Center had a higher share or an increase rate than those in the heart of Tokyo.

5.2 Workers' Business Trips Per Capita

The number of business trips made per capita of workers (hereinafter referred to as "the basic generation unit of business trips" or "the generation unit") decreased in the 10 years from 1978 to 1988. Although the industry-wise overall trend was toward decreasing, business trips increased in some industries (the financing/insurance and the mining/construction) and decreased in some others (the manufacturing and the services). There are also industries such as the electricity, gas, heat supply and water, and the transportation/communication, where the generation of business trips greatly varied from district to district. In Shinjuku Sub-Center, the financing/insurance industry saw increases in the number of workers, and the basic generation unit of business trips also increased. On the other hand, although workers in the industry in the heart of Tokyo increased, the basic generation unit decreased, indicating that the financing/insurance business in the heart of Tokyo was undergoing a qualitative change to one with fewer business trips.

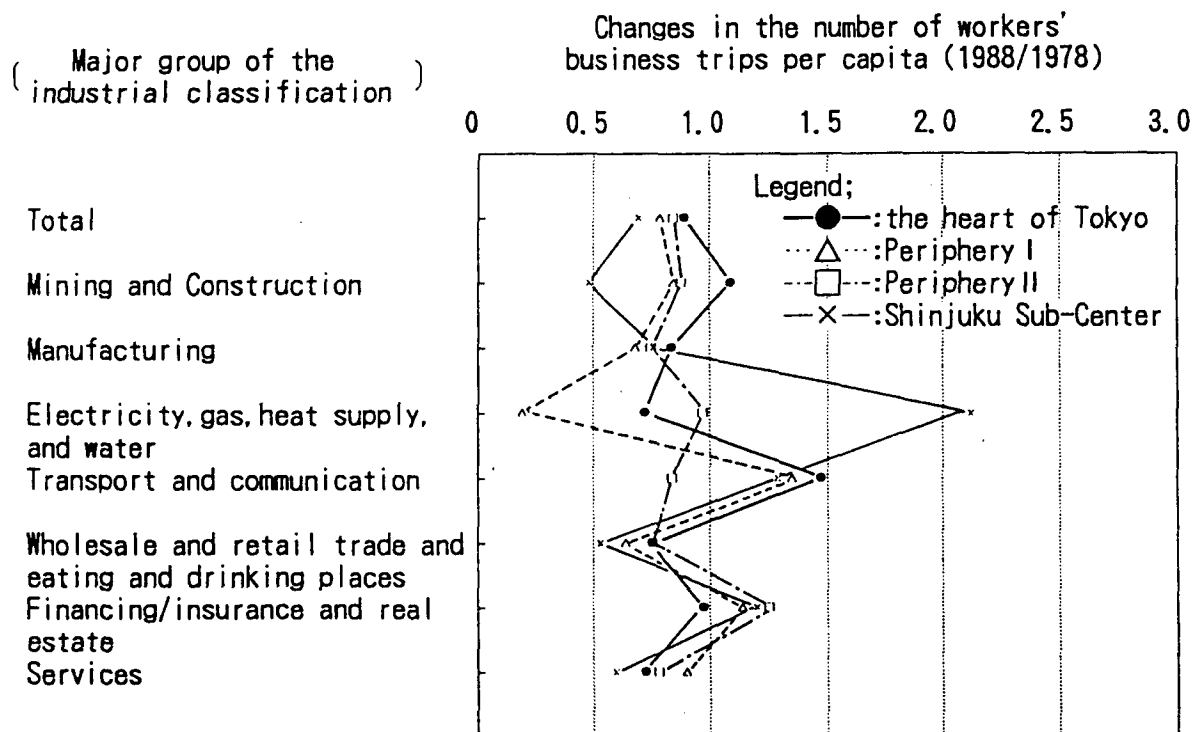


Figure-6 Changes in the basic generation unit of business trips in the 10 years from 1978 to 1988

6. BUSINESS TIES BETWEEN SHINJUKU SUB-CENTER AND THE HEART OF TOKYO/PERIPHERIES

6.1 Change of Business Trip Ties between Shinjuku Sub-Center and the Heart of Tokyo/Peripheries

In 1988, the number of business trips from the heart of Tokyo or its peripheries to Shinjuku Sub-Center was 12,979, and the number in the opposite direction was almost the same: 13,272.

The number of business trips originating in Shinjuku Sub-Center and going to the heart of Tokyo or its peripheries increased by 1.81 times from 1968 to 1988, and also the share in all the business trips went up from 14% to 19%. The rate of increase was far greater than that of all the business trips originating in the Sub-Center, which was 1.38 times. This means that in proportion to the formation of Shinjuku Sub-Center, its business ties with the heart of Tokyo and the peripheries were strengthened. (Figure-7)

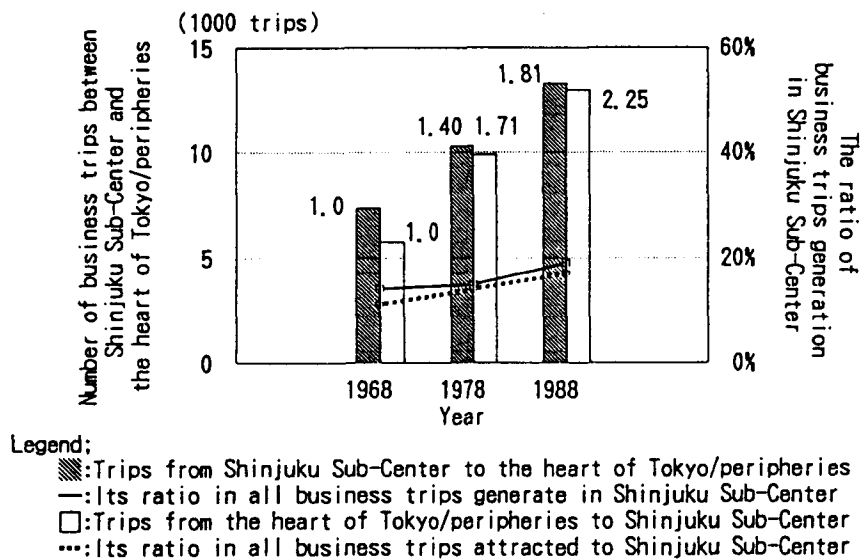


Figure-7 Change of business trip tie between Shinjuku Sub-Center and the heart of Tokyo/peripheries

Changes in business trips from Shinjuku Sub-Center to the heart of Tokyo and Peripheries I and II show that the basic generation unit of business trips decreased by 0.90 times from 0.049 trip/person to 0.044 trip/person during the 10 years from 1978 to 1988. But, as compared with the decrease of the basic generation unit of all business trips (0.70 times), the ratio of decrease was small, and it is indicated that the relationship of the Sub-Center with the heart of Tokyo and Peripheries I and II became relatively closer.

A closer look at business trips going to the heart of Tokyo or Peripheries I and II shows that during the 10 years from 1978 to 1988, in all the industries except manufacturing and agriculture/forestry, business trips increased, and the financing/insurance industry and the service industry, in particular, registered a conspicuous increase of 2.68 times and 2.00 times respectively, exceeding the increase in total business trips (1.29 times).

The above examination indicates that business trips originating in Shinjuku Sub-Center were more and more strengthening its relations with the heart of Tokyo and its peripheries, and

also that the financing/insurance industry and the service industry of the Sub-Center, in particular, had close relations with those areas.

6.2 Consideration on Business Ties between Shinjuku Sub-Center and the Heart of Tokyo/Peripheries

A specialized coefficient was set up as an indicator to grasp qualitative characteristics of mutual business trips between Shinjuku Sub-Center and the heart of Tokyo/Peripheries.

$${}_k\alpha_{ij} = \frac{{}_k t_{ij} / {}_k T_i}{\sum_k {}_k t_{ij} / \sum_k {}_k T_i} \quad \text{Eq. 1}$$

Here;

- ${}_k\alpha_{ij}$: a specialized coefficient concerning the characteristic k out of business trips originating in district i and going to district j
- ${}_k t_{ij}$: business trips concerning the characteristic k originating in district i and going to district j
- ${}_k T_i$: all business trips having characteristic k originating in district i

For example, if the value of the coefficient is more than 1.0, it shows that business trips having characteristic k out of business trips originating in district i have a higher possibility that they were destined for district j than those with other characteristics. Table-7 shows the characteristics whose specialized coefficient exceeds 1.0.

Table-7 The specialized coefficient of business trips between Shinjuku Sub-center and the heart of Tokyo/peripheries

	Characteristics of Business trips	Business trips from Shinjuku Sub-Center to the heart of Tokyo/peripheries	Business trips from the heart of Tokyo/peripheries to Shinjuku Sub-Center
Occupation	Professional and technical workers	1.23	1.10
	Managers and officials	1.21	1.02
	Sales and service occupation	1.04	1.15
Industry	Construction	1.26	1.03
	Financing and insurance	0.98	1.29
	Services	1.07	1.27
Facility	Facilities for business	1.33	1.09
	Facilities for commerce	0.60	1.39
Purpose of business	For conference or meeting	1.03	0.99
	For sales, delivery or buying	0.92	1.09

Business trips of office workers originating in Shinjuku Sub-Center have a high specialized coefficient, marking that office workers there had much closer ties with the heart of Tokyo

and the peripheries than other workers.

On the other hand, business trips originating in the heart of Tokyo or the peripheries and going to Shinjuku Sub-Center showed that sales workers had high regional business ties as well as professional and technical workers, and managers and officials among office workers.

Business trips of the financing/insurance and service industries had a lower specialized coefficient than those originating in the heart of Tokyo and the peripheries. As described in 6.1, in the financing/insurance and service industries, business trips originated in Shinjuku Sub Center and going to the heart of Tokyo and the peripheries were greatly increasing. But in terms of the specialized coefficient, it can be pointed out that compared with other industries, the financing/insurance industries in Shinjuku Sub-Center have not necessarily reached a stage of having strong ties with the heart of Tokyo and the peripheries yet.

As seen above, the use of the specialized coefficient makes possible a relative and quantitative grasp of which business trips, out of those originating in a certain district, and with what characteristics, had strong ties with other districts. It was revealed that business trips between Shinjuku Sub-Center and the heart of Tokyo and the peripheries had differences in characteristics according to the direction of trips.

6.3 Progress and Characteristics of Modal Choice

(1) The Present Situation and Progress of Modal Choice

In 1988, rail transportation was used for 52% of all the business trips in the heart of Tokyo, in Periphery I 46%, in Periphery II 43%, and in Shinjuku Sub-Center 50%. In each district, the role railways played was highly important. (Figure-8)

Within the limits of business trips originating in Shinjuku Sub-Center, in particular, the share of railways as a means of transportation was 76% for trips arriving at the heart of Tokyo, and 70% and 64% respectively for those arriving in Peripheries I and II. It can be pointed out therefore that railways were extremely important for Shinjuku Sub-Center's business activity with the heart of Tokyo and the peripheries.

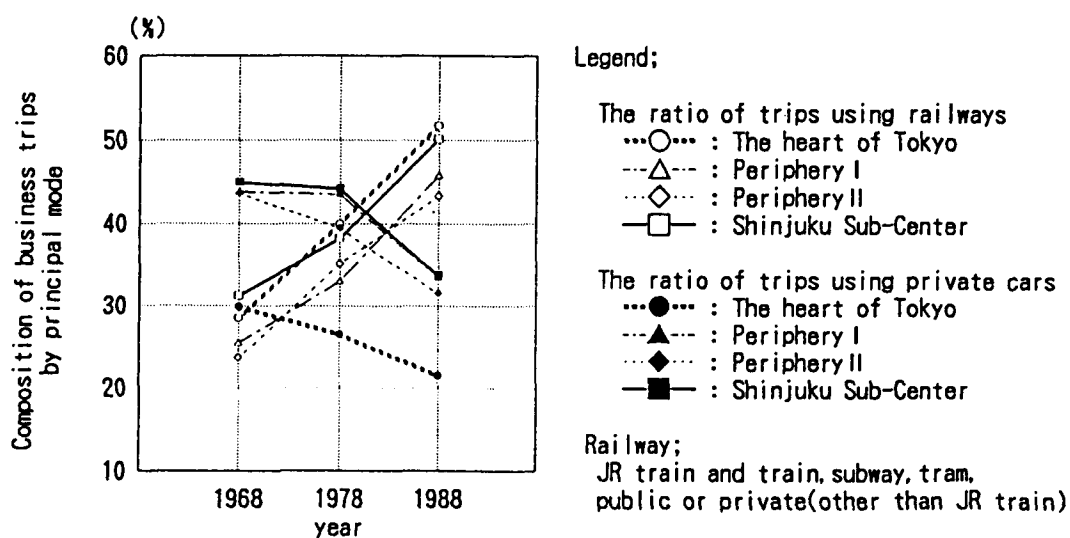


Figure-8 Changes in modal split of business trips

Figure-8 shows that the time-series rate of railway use was increasing in all districts.

In 1968, the share of cars was almost the same as or bigger than that of railways, but it

remarkably dropped in all districts during the 20 years from 1968. One of the reasons might be that of the roads leading to the heart of Tokyo and the peripheries, those running through Shinjuku Sub-Center were especially congested, making it relatively difficult to use cars because of traffic congestion. (Table-8)

As to railway facilities, on the other hand, during the same 20 years one subway line connecting the two districts was opened, augmenting carrying capacity and offering a wider choice of lines. (Table-9)

Table-8 Traffic congestion between Shinjuku Sub-Center and the heart of Tokyo/peripheries

Item	the indicators of traffic flow by cars
Principal roads	
a) Traffic capacity (1000veh./day)	547
b) Traffic volume per day (1000veh./day)	861
c) Congestion rate ($c=b/a$)	1.57
The Metropolitan Expressway	
a) Traffic capacity (1000veh./day)	204
b) Traffic volume per day (1000veh./day)	326
c) Congestion rate ($c=b/a$)	1.60

Source: Data from Bureau of City Planning, Tokyo Metropolitan Government

Table-9 Progress of public transit(rail) capacity between Shinjuku Sub-Center and the heart of Tokyo/peripheries

Item	1968	1978	1988
a) A number of railway lines	3	3	4
b) Transporting capacity (persons/day)	902,079 (1.0)	870,604 (0.97)	1,087,127 (1.21)
c) Transported passengers(persons/day)	709,401 (1.0)	725,196 (1.02)	852,237 (1.20)
d) Congestion rate ($d=c/b$)	78.6%	83.3	78.4

Source: Annual Report on Urban Traffic 1968, 1978 and 1988

Judging from the fact that in 1968 the share of cars was high, and that the use of cars is high for inter-district trips, it is expected that potential demand for the use of cars for business trips is high.

On the other hand, for inter-district business trips, walking was very often used: 49% in the heart of Tokyo, 42% and 39% in Peripheries I and II, and 58% in Shinjuku Sub-Center. It was revealed that two wheeled vehicles and taxis were highly used for inter-district trips.

(2) Characteristics of Modal Choice in Shinjuku Sub Center and the Heart of Tokyo/Peripheries

a) Formation of Models of Modal Choice

Compared with other purposes, business trips seem to require quickness, reliability and punctuality of transit time. From this point, this paper studies the modal choice between

railways and cars as regards business trips in Shinjuku Sub-Center, and the heart of Tokyo/Peripheries.

In 1988, railways and cars were used for more than 80% of the business trips as transportation means between the two districts. The Logit Model was applied to explain the modal choice between the two transportation means.

In this model, as variables for explaining utility, the average time required by rail and car between the zones (indicator to describe the quickness of transit), and the fluctuation values of the time required (punctuality and reliability of transit time) were used.

$$Pr = Xr / (Xr + Xc) \quad \text{Eq. 2}$$

$$Pc = 1 - Pr \quad \text{Eq. 3}$$

Here;

Pr : a ratio of business trips using railways

Pc : a ratio of business trips using cars

Xr : the number of business trips using railways

Xc : the number of business trips using cars

As fluctuation values, a standard deviation/average time required between zones was used. For the objectives of the analysis, OD (origin-destination) pairs between the heart of Tokyo, Shinjuku Sub-Center and the peripheries were used to formulate a modal choice model by means of multiple regression analysis.

$$Pr = 1/[1 + \exp \{ \underset{(2.15)}{-0.072 (Tc-Tr)} - \underset{(1.88)}{2.380 (Cc-Cr)} - 0.778 \}] \quad \text{Eq. 4}$$

Here;

Pr : a rate of business trips using railways

Tr : average travel time required by railways

Tc : average travel time required by cars

Cr : variable coefficient of the travel time required by railways

Cc : variable coefficient of the travel time required by cars

- Multiple correlation coefficient $R = 0.70$ (squared $R = 0.49$)

- Parentheses show the t- value

- F- value : 4.30

- Significant level : 10%

b) Characteristics of Modal Choice

In Eq. 4 it is clarified that the modal choice of business trips between the target districts can be explained by the difference in the average time required by rail and car (quickness of transit), and also the difference in variable coefficients (punctuality and reliability of the time required).

Through the above study of a series of models, the following information was obtained on the characteristics of means of business trips between Shinjuku Sub-Center and the heart of Tokyo/the peripheries.

#1. As the means of transportation, railways have been used more frequently because of quickness, punctuality and reliability of transit time.

#2 This fact shows that in accordance with the business concentration in Shinjuku Sub-Center, the rate of office workers in all the workers there increased, and that because of the

increase in the service industry and the financing/insurance industry in total industries, there was a tendency to place more importance on time factors for business trips.

7. QUANTITATIVE GRASP OF THE EFFECT OF THE FORMATION OF SHINJUKU SUB-CENTER

7.1 Method of Analysis

It should be reasonable to think that because of the formation of Shinjuku Sub-Center, companies moved to the Sub-Center from the heart of Tokyo and the peripheries, causing changes in the commuting structure and business activities. Were it not for the formation of Shinjuku Sub-Center, the increase of workers and the concomitant commuting and business trips would have concentrated in the heart of Tokyo or the peripheries.

Therefore, this paper constructed the following hypothesis to grasp quantitatively the influence and effect of the formation of Shinjuku Sub-Center from aspects of municipal public transportation.

- During the 10 years from 1978 to 1988, the number of workers increased by about 61,400 persons in the Shinjuku Sub-Center zone (0233). Assuming that if Shinjuku Sub-Center had not been constructed, these workers would have been scattered about each of the seven zones of the heart of Tokyo and the peripheries, the prediction and estimation were made about commuting and business trips in that case.
- This paper hypothesizes that workers would be scattered in the seven zones in proportion to the present number of workers in each zone, and that commuting and business trips would increase in proportion to the increase in workers.
- This paper hypothesizes that the distribution pattern of commuting and business trips would indicate the present distribution pattern of each zone (88PT).
- In order to grasp the effect on urban public transportation, this paper calculated the total person trips-km to be defined by Eq. 5 and Eq. 6, and compared the differentials between the present traffic condition (Shinjuku Sub-Center exists) and the hypothesis (the Sub-Center does not exist).

$$QC_j = \sum_{i=1}^n X_{ij} \cdot D_{ij} \quad \text{Eq. 5}$$

$$QB_j = \sum_{i=1}^n Z_{ij} \cdot D_{ij} \quad \text{Eq. 6}$$

Here;

QC_j : the total person trips-km in commuting in the target zone j ($j=1-8$)

QB_j : the total person trips-km in business in the target zone j ($j=1-8$)

X_{ij} : numbers of commuting trips attracted to zone j from zone i

Z_{ij} : numbers of business trips between zones i and j

D_{ij} : spacial distance between the zones i and j

n : number of target zones of PT ($n=503$).

7.2 Effect of the Formation of Shinjuku Sub-Center

The result of an estimate of the formation of Shinjuku Sub-Center is shown by Table-10 and Table-11, and it can be summarized as follows:

- Due to the formation of Shinjuku Sub-Center, both the numbers and the total person trips-km of commuting and business increased in the Sub-Center, but they decreased in the heart of Tokyo and the peripheries. Especially, that of commuting decreased by 0.95 there.
- As a result of the formation, the total person trips-km of commuting decreased by 0.99 but that of business trips increased by 1.01 in amount of districts to be studied.
- However, the total person trips-km of business is only about 15% of the total person trips-km of commuting, so as the whole the total person trips-km, the decrease in the commuting flow (546,000 trips-km) was far greater than the increase of that of business (56,000 trips-km), indicating that the Sub-Center has had a great effect.
- The number of business trips increased by 1.19 times between Shinjuku Sub-Center and the heart of Tokyo/the peripheries. As business trips are originated during off-peak hours, there is no problem of capacity, and this raises the efficiency of railways.

Table-10 Commuting trips and the total person trips-km

(unit: 1000 trips, 1000 trips-km)

Item	Districts	The present traffic condition Shinjuku Sub-Center exists (a)	The hypothesis traffic condition the Sub-Center does not exist (b)	Increase (a-b)	Increase rate (a/b)
Numbers of trips	The amount of districts	2,286	2,286	0	1.00
	The heart of Tokyo/Peripheries	2,328	2,234	-106	0.96
	Shinjuku Sub-Center*1	276	158	118	1.74
The total person trips-km	The amount of districts	79,600	80,146	-546	0.99
	The heart of Tokyo/Peripheries	67,424	70,632	-3,028	0.95
	Shinjuku Sub-Center*1	6,514	4,060	2,454	1.74

Note: *1) Forecasted district is only composed of 0233 (0232 excluded)

Table-11 Business trips and the total person trips-km

(unit: 1000 trips, 1000 trips-km)

Item	Districts	The present traffic condition Shinjuku Sub-Center exists (a)	The hypothesis traffic condition the Sub-Center does not exist (b)	Increase (a-b)	Increase rate (a/b)
Numbers of trips	The amount of districts	1,303	1,303	0	1.00
	The heart of Tokyo/Peripheries	1,103	1,120	-17	0.98
	Shinjuku Sub-Center*1	106	87	19	1.22
	The section*2	23	20	3	1.19
The total person trips-km	The amount of districts	11,083	11,027	56	1.01
	The heart of Tokyo/Peripheries	9,119	9,215	-86	0.99
	Shinjuku Sub-Center*1	1,147	965	182	1.19
	The section*2	166	139	27	1.19

Note: *1) Forecasted district is only composed of 0233 (0232 excluded)

*2) The section between Shinjuku Sub-Center and the heart of Tokyo/Peripheries

8. CONCLUSION

The main points of the information obtained by this study are as follows:

- a) In Shinjuku Sub-Center, the concentration of business and business trips are increasing, indicating that it is in the process of growing as a central business district in which the functions of the heart of Tokyo are concentrated.
- b) In the target districts, the basic generation unit of business trips is decreasing, but industries are divided into those whose generation unit is increasing and those whose generation unit is decreasing.
- c) Business in the heart of Tokyo is undergoing a qualitative change to one having fewer business trips. Remarkable district-wise differences in the basic generation unit of business trips in the financing/insurance industry seem due to the fact that the business structure and contents (e.g. international financing) of the heart of Tokyo are different from those (e.g. loans to companies) of Shinjuku Sub-Center.
- d) It was revealed that Shinjuku Sub-Center has concentrated its business functions by strengthening its business ties with the heart of Tokyo and the peripheries, and that business trips between these districts required quickness, punctuality and reliability of transit time, leading to increased use of railways.
- e) The formation of Shinjuku Sub-Center reduced the total person trips-km of commuting, as trips were shortened, especially, in the heart of Tokyo and the peripheries, that decreased by 0.95. On the other hand the total person trips-km of business increased in the amount of districts to be studied. However, the total person trips-km of business is only about 15% that of commuting, so as the whole the total person trips-km, it was confirmed that the decrease in the value of commuting had greater effect than the increase of that of business in the whole the total person trips-km.

In the future, studies should be made on the following points, heeding the relevancy between business concentration and business trips.

- a) Detailed analysis of the process of the concentration of business functions in relation to indicators other than the number of workers.
- b) Theoretical and positive analysis for elucidating business ties among districts.
- c) Detailed analysis of business modal choice to predict the effect of the plan of core business cities which is now under way.

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